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The Status of Source Emissions Monitoring in the United States Air Program And Concepts for Continued Improvement

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Abstract

The 2005 Air Quality Management Group (AQMG) recommendations to the US Clean Air Act Advisory Committee echoed many of those made by the National Academies' National Research Council (NRC) 2004 report on air quality management in the United States. Among the recommendations are improvements to emissions monitoring and assurance of compliance with pollution emissions reductions regulations. The AQMG also noted that improved emissions measurements and reporting will enhance the ability of the Environmental Protection Agency (EPA) Air Quality Management Program to conduct effective assessments.

In this paper, we will describe the status of the current approaches to emissions monitoring in EPA regulations and potential future responses to the AQMG recommendations. We believe that the concepts and principles discussed herein could result in improved and more direct emissions monitoring and improved progress tracking for the air program. Those principles that apply in identifying and applying improved monitoring would center on flexibility in technology selection that provides incentives for direct emissions monitoring, accounts for uncertainty, allows for advancements in technology, and provides for practical implementation. Addressing this latter concern would include a balancing of monitoring costs with environmental, health, and program benefits with a predilection towards improving program and source accountability. For example, allowing flexibility of adjustable applicable requirements may be appropriate in accounting for the uncertainty. Such adjustments could include alternative averaging times and alternative forms of applicable limits commensurate with the capabilities of a monitoring selection.

Introduction

In January 2004, the National Research Council of the National Academies issued a report of the assessment of and recommendations for managing the air quality program in the United States[1]. The NRC formed the Committee on Air Quality Management, who produced the report, to examine the role of science and technology in implementing the US Clean Air Act and recommend ways to enhance the scientific and technical foundations for air quality management in the US. The report delivered to the Environmental Protection Agency (EPA) addresses the broad range of activities associated with managing air quality highlighting the success the program has achieved so far while identifying several areas in need of improvement.

One particular area of concern identified in the report is the recognition that stationary source air emissions monitoring techniques, practices, and requirements can and do vary widely across EPA, State, local and Tribal air quality management programs. Some monitoring techniques, practices, and requirements are outdated and do not reflect changes in the pollutants of interest (e.g., total suspended particulate matter versus particulate matter of 2.5 microns aerodynamic particle size or less - $PM_{2.5}$). The report notes that many applied technologies and practices are insufficient to ensure ongoing compliance with applicable requirements or to provide program assessment data. Further, the report cites that air quality management programs need to recognize and make use of current and future advancements in technology that make available more cost effective approaches for measuring pollutant emissions and other relevant source operating parameters on a continuous basis.

Among the Committee's recommendations are:

- Strengthen scientific and technical capacity to assess risk and track progress. including applying new emissions monitoring technology,
- Expand national performance-oriented control strategies including development of technology-neutral standards and market-based approaches through expanded use of continuous emissions monitoring systems (CEMS), and
- Transform the national regulatory planning process with an emphasis on tracking and assessing strategy performance including measuring benefits associated with new and innovative technologies.

These recommendations have led the Agency to reassess the role of emissions monitoring specifically in developing, supporting, and implementing the stationary source regulatory program. The EPA management established an internal work group to review current policies regarding the status of emissions monitoring practices and assess how the Agency may address the NRC recommendations. The work group reviewed the Committee's recommendations and other resources and determined that improved monitoring of emissions from significant air pollutant sources will have multiple benefits. Among them are:

- Improved program performance including cost-effective reductions in air pollutants emissions,
- Enhanced capabilities for program assessment in accordance with the recommendations from the NRC and EPA's Clean Air Act Advisory Committee,[2]
- More direct and supportable accountability for source owners in complying with applicable emissions standards, and

- Increased public awareness and program transparency.

In this paper, the work group outlines the history and characteristics of the current air program related to source emissions monitoring. The work group also identifies key concepts for improving regulatory development practices consistent with the NRC recommendations and, in doing so, identified several basic values on which to base decisions on monitoring for the betterment of the Air Program.

History

Regulatory development practices

The EPA has for most of its regulatory history applied monitoring through industry source category-specific and pollutant-specific regulations (e.g., SO_2 emissions limits for fossil fuel fired utilities) without an established coordinated monitoring program strategy. The regulatory development process has relied on case-by-case assessment to establish what testing and monitoring requirements apply in these individual rules as well as how the data are to be used to determine compliance. There are some source categories for which the Agency has promulgated rules and the infrastructure for CEMS including a national acid rain emissions trading program.[3] More often, continuous monitoring that is required in source category-specific rules has been limited to surrogate pollutant or condition (e.g., opacity) or operational parametric monitoring only periodically and minimally correlated with emissions of the regulated pollutant.

The cost and benefits impact assessment required for each Federal regulatory action has historically focused on demonstrated available control technologies and the associated potential emissions reductions capabilities in calculating costs and benefits resulting from implementing the particular rule. The rule assessment process typically accounts for the costs of monitoring and testing in the narrow context of the reporting and recordkeeping costs associated with the particular rule and without clear acknowledgment of the potential benefits of better monitoring.

The State and local agencies develop regulations through State Implementation Plans (SIPs) to implement the national ambient air quality standards in a manner that mirrors the Federal practices in many ways. There are few SIPs that require source emissions monitoring more rigorous than found in Federal requirements. Exceptions include various cap and trade programs and some permitting actions that require the use of direct continuous emissions monitoring.

This established rule-making approach has been successful in significantly reducing pollutant emissions in the US.[4] Establishing equipment-based standards based on initial performance testing demonstrations, and periodic testing or operational monitoring has resulted in better controlled pollutant sources and greatly improved air quality since 1970. The monitoring and testing required and implemented in these regulations have improved the knowledge of pollution control capabilities and operating practices.

Remaining Challenges

On the other hand, limited attention to the role of direct emissions monitoring as part of an overall pollution control strategy has produced few records of source-specific

pollutant emissions on a continuous basis that would enable program review, source compliance determinations, or other source emissions characterization purposes. Further, the rule-making approach based on the assumption that emissions testing and monitoring activities impose costs without accounting for environmental and operational flexibility benefits exaggerates such costs and minimizes the value of improved monitoring in implementing effective comprehensive control strategies.

The Agency's established rule-making practice only minimally addresses incentives for industry source operators to take advantage of extra-regulatory opportunities to apply new emissions monitoring technologies. While the regulations provide clear direction or requirements for monitoring with the intention to assure compliance, failure to provide for flexibility to apply or encourage use of advanced technologies has made some industry operators reluctant to install and operate new CEMS or to pilot new advanced monitoring technologies when not otherwise required.

Concepts for a Revised Approach

Monitoring the pollutant(s) of interest

One of the key elements in effective source emissions monitoring is a focus on the pollutant that the applicable rule intends be controlled. Scientific data and technical information are keys to determining what pollutants need to be reduced, by how much, and over what scale and time. Air quality management is by nature an iterative process of continuous improvement. Through direct measurement of source emissions of the pollutant(s) of interest, the regulatory air programs and industry sources can assess more effectively and build to improve the effectiveness of implementing critical pollutant reduction strategies. Assessing direct emissions monitoring data from related source categories may, for example, point the decision maker towards monitoring particulate matter emissions directly from another source category to verify a rule's effectiveness and to assure necessary reductions of particulate matter control requirements, as opposed to monitoring opacity or other indirect operational or surrogate parameters.

Another important element in effective monitoring is identifying relevant existing direct pollutant emissions monitoring methodologies, categorizing applications for which these methodologies are appropriate, and providing protocols for conducting these measurements. The Agency has means to identify and support development of new emissions monitoring technologies for pollutants that are regulated currently or may be regulated in the future. Effective monitoring practices would include the application of existing monitoring technologies to existing source categories for which additional demonstration is warranted. Continuing to build the support resources for improved monitoring options will allow the decision maker clearer and more effective choices. Emphasis on the development of effective sector-based multi-pollutant rules, for example, may be more effective with the application of continuous emissions monitoring systems (CEMS) if such tools can be made available.

Accounting for Uncertainty

Air quality management decisions are more likely to achieve intended goals at least cost if the decision makers have, understand, and apply information on the uncertainties

inherent in any emissions characterization or quantification approaches. Public and industry acceptance may also be greater with awareness that such uncertainties have been responsibly addressed. Collecting and assessing source emissions and other measurement data uncertainty information would significantly improve the Agency's technical analyses of the effectiveness of regulatory actions to address complex air quality management problems and decisions. Informed application of measurement uncertainties can help target the use of resources towards focusing air quality management decisions on implementing emissions reduction activities that will have the largest payoff.

Accounting for data uncertainty in designing and applying effective monitoring means identifying and measuring the quality of monitoring data, reducing emissions data measurement or correlation uncertainty, and applying the known quality of data to decision making in a transparent manner. With that information, regulatory decision makers could recognize and accommodate measurement uncertainty in providing flexibility in the selection of monitoring methods and compliance evaluation procedures. For example, adjustments to applicable emissions limitations (e.g., range of averaging times associated with different technology options) can be used to provide for flexible monitoring selection. Standard data assessment protocols for assessing data quality factors, such as the rigorousness of the correlation with emissions and data collection frequency, can account for uncertainty consistent with the characteristics of a monitoring approach. With directionally appropriate adjustments, the regulatory application of such protocols could allow for flexibility in the monitoring selection process and, potentially, promote more continuous and more direct emissions monitoring.

Adjusting regulatory development practices

Through regulatory development activities that involve public review and comment prior to finalization of source category-specific rules, the Agency can most readily advance the monitoring selection practices that will provide improved data for compliance and program assessment. The Agency's rule development schedule is most often tied to Clean Air Act requirements designating source categories for regulatory attention. As noted above, the costs of monitoring and the decisions as to what level of monitoring will be included in a regulation have historically been linked with administrative activities. An effective regulatory development process that supported better monitoring would separate monitoring application decisions from those for reporting and record keeping activities. The updated process would also facilitate explicit consideration of costs and benefits associated with monitoring options, including the potential for health risk reduction and other environmental benefits.

Factors to assess in deciding on appropriate monitoring approaches include the magnitude of expected emissions reductions, contributions of the pollutants emitted to health risks, the relevance and effectiveness of existing monitoring technologies including accounting for associated data uncertainty, availability of better methods or procedures, and source or source category compliance histories. There are supportable examples and the assessment tools available to link the data produced by various monitoring options with potential emissions reductions. Such data and tools will allow the regulatory process to assess the value of advanced monitoring technologies in new and revised rules in a manner not heretofore available.

Rather than imposing unnecessarily onerous monitoring requirements across the board for all source applications, decisions resulting from an updated rule development process would target opportunities with the most promise of benefits based on a range of technical, costs, and benefits considerations. These considerations would include, but not be limited to, the significance of source category contributions to air quality problems, the potential for additional reductions in emissions, the relative cost and availability of monitoring techniques, and the relative potential for better monitoring to improve emissions reductions performance, verify compliance, and provide meaningful information about emissions.

Because the Agency's regulatory development agenda focuses mostly on specific time-sensitive requirements of the CAA, opportunities to advance better monitoring in new or revised rules are necessarily limited and thus can be slow to come to fruition. Tools to encourage development and application of advanced direct emissions monitoring technologies independent of new or existing regulatory requirements can help advance technology as well as add to information about emissions.

Populating the monitoring tool box

We recognize that not all monitoring approaches and technologies are appropriate to all source types or sizes. Further, even where technically feasible, the costs of upgrading existing monitoring may not be justified by the potential for significant reductions in emissions and risk. Consequently, having a diversity and breadth of monitoring options including continuous data collection will be critical to implementing effective source emissions monitoring. For example, we could merge information and specifications for ambient and stack stationary source air emissions monitoring technologies, where appropriate, in order to capitalize on the strengths of each.

The Agency has performance specifications for evaluating and verifying the on-site viability of CEMS and predictive emissions monitoring systems for a number of criteria and hazardous pollutants commonly emitted from stacks.[5] The Agency continues to expand the cadre of tools available to apply in regulatory and other activities. These include:

- Performance specifications for continuous control device operational parametric monitoring (e.g., maintaining combustion temperature conditions indicative of compliance);
- Performance specifications for predictive emissions monitoring systems used to produce data in units of the emissions limit using operational data correlated with test method data;
- Documentation demonstrating the viability of and performance specifications for continuous multiple metals emissions monitoring systems; and
- Documentation supporting the development and implementation of flexible operating permits relying particularly on establishing emissions caps and monitoring commensurate with measuring continuous compliance.

The Agency also has design and performance criteria for continuous point monitors applied in the national ambient air quality monitoring system. Vendors and researchers have explored applying traditional ambient monitoring technology as well as open-path devices to quantifying source-specific emissions. To date, there are few air program avenues, regulatory or otherwise, available for applying such technology for the purpose

of compliance or source assessment emissions monitoring. We need to explore new regulatory and other vehicles and incentives for expanding the availability of technologies for source emissions monitoring, including remote and fence-line monitoring approaches.

Agency decision-making practices may include mechanisms to provide information about and promote new and advanced to support the availability and public acceptance of new and advanced technologies. The emphasis will be on seeking the best practicable solutions to monitoring of source-specific emissions. The Agency has assembled guidance and other support materials and made those available through the Internet websites (http://www.epa.gov/ttn/emc/cem.html, http://www.epa.gov/ttnemc01/ctm.html, and http://cfpub.epa.gov/mkb/).

Piloting the new approaches

Demonstrating the viability of these principles and practices while finalizing specific operational elements for general application is an important element in developing acceptance in the Agency and elsewhere. There are current and scheduled regulatory actions that may be opportunities for demonstrating and refining the practices described in this paper. Several criteria key factor into selecting candidate projects:

- Timeliness - the regulatory development process is at a stage (e.g., prior to proposal or finalization, in the initial data collection and analysis stage) at which decisions about monitoring selection and justification are possible and effective;
- Emissions data availability - the rule developers have emissions data from multiple sources and for relatively long periods of time that will allow for a thorough statistical assessment of the costs and benefits of various monitoring approaches, including alternative averaging times and limits;
- Opportunity to apply advanced technologies - the source category has been subject historically to basic emissions testing or other simple means for demonstrating compliance and there exist continuous monitoring technologies heretofore rarely applied (e.g., CEMS for particulate matter emissions); and
- Opportunity to effect significant emissions reductions - the source category emits large amounts of criteria pollutants or particularly hazardous pollutants for which maintaining optimum emissions controls through better monitoring can result in measurably significant environmental and health benefits.

The work group has begun developing guidance to assess the costs and benefits related to the range of monitoring frequencies and technologies that could be applied to control of particulate matter emissions. These initial assessments indicate that better (i.e., more frequent and directly related to emissions) monitoring can increase the emissions reductions achievable by up to about 7 percent. The reductions are attributable to quicker responses to control device operational problems with continuous monitoring data as opposed to annual or other infrequent monitoring. Further, even though the more continuous monitoring technology is more expensive in terms of capital and operating expenses than manual methods, the costs per ton of emissions reduced can actually decrease by of a factor of 2 to 5 when continuous monitoring is applied in place of infrequent manual testing.

Building on the experience with this particulate matter monitoring effectiveness assessment tool, we are finalizing the regulatory impact (costs and benefits) analysis

associated with implementing a national monitoring rulemaking implemented through the operating permits program to monitor compliance with existing requirements. In this analysis, the group is assessing the costs and benefits associated with improved monitoring for a variety of monitoring approaches ranging from simple record keeping to CEMS. This costs and benefits analysis is expected to form the basis for a generic model to use in documenting and justifying monitoring for all future air program rules by offsetting the costs of better monitoring data collection with measurable environmental and health benefits.

Conclusions

The established regulatory development practices have led to significant improvements in environmental and health protection in the US over the past 30 to 35 years. There are multiple reasons to review the regulatory development process and in particular relative to advancing the use of better emissions monitoring. For one, better emissions monitoring can produce even greater emissions reductions cost effectively. We have identified practices and products necessary to support the development and application of better monitoring and there are several projects underway to test and complete these products.

Additionally, the recommendations from the National Academies and the Clean Air Act Advisory Committee direct the Agency to reassess the current regulatory structures and development procedures relative to producing better emissions data. We believe that such assessment would include strengthening scientific and technical capacity for applying new emissions monitoring technology, emphasizing the tracking of program performance, and targeting cost-effective opportunities for applying new and innovative monitoring technologies. Such updated rule development practices should improve the quality of data on emissions of pollutants of interest, improve the status of compliance for most industrial applications, and, most critically, produce additional emissions reductions and environmental and health benefits.

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